The effect of *Leucaena leucocephala* leaf extract on the Texture of Nile Tilapia (*Oreochromis niloticus*) Fingerlings

By

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THESIS DECLARATION

I hereby declare that the work embodied in this report is the result of the original research and has not been submitted for a higher degree to any universities or institutions.

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I certify that the report of this final project entitled "The effect of *Leucaena leucocephala* leaf meal on the Texture of Nile Tilapia (*Oreochromis niloticus*) Fingerlings" by Aida Syazana Binti Musa, matric number F14A0429 has been examined and all correction recommended by examiners have been done for the degree of Bachelor of Applied Science (Husbandry Science) with Honours, Faculty of Agro-Based Industry Universiti Malaysia Kelantan.

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The Effect of *Leucaena leucocephala* Leaf Extract on The Texture of Nile Tilapia (*Oreochromis niloticus*) Fingerlings

Abstract

The purpose of this study is to identify the difference of Tilapia fish (*Oreochromis niloticus*) texture fed with different concentration of *Leucaena leucocephala* leaf extract sprayed on commercial feed. The texture parameter of the Nile tilapia (*O. niloticus*) was observed by using three different treatments (Treatment 1= 0% of *L. leucocephala* leaf extract, Treatment 2 = 10% of *L. leucocephala* leaf extract, and Treatment 3= 20% of *L. leucocephala* leaf extract) as feed additive. The Nile tilapia fish with an average weight of 18.3g were randomly picked for the preparation of samples. The results showed that the maximum hardness of (5651 ± 65.80) was observed in Treatment 2. Moderate hardness cycle of (5662.83± 85.26) was observed in Treatment 3 and low hardness (5579.33± 53.08) in Treatment 1. The maximum cohesiveness of (0.79 ± 0.14) was observed in Treatment 3 followed by (0.53 ± 0.07) in Treatment 1 and (0.50 ± 0.03) in Treatment 2. The level of springiness in Treatment 1 (61.39 ± 10.24) showed the highest result compared to Treatment 3 (51.30 ± 0.22) and Treatment 2 (51.23 ± 0.12). For gumminess, Treatment 3 (4144.67 ± 629.51) gave the best result compare with others and for chewiness, Treatment 3 (2085.90 ± 317.63) resulted higher followed by Treatment 1 and Treatment 2 with (1673.03 ± 182.49) and (1364.27 ± 89.94) respectively. From the analysis, the best texture preferences of Nile Tilapia fed with *Leucaena leucocephala* leaf extract showed in Treatment 3.

Key Word: Fish Texture*, Leucaena Leucocephala* Leaf*, Oreochromis niloticus,* texture*,* sensory evaluation

Kesan Potensi Ekstrak Daun *Leucaena leucocephala* Pada Tekstur Anak Ikan Nil Tilapia (*Oreochromis niloticus*)

Abstrak

Tujuan kajian ini adalah untuk mengenalpasti perbezaan tekstur anak ikan Tilapia (*Oreochromis niloticus*) yang diberi diet pemakanan yang mengandungi kadar konsentrasi ekstrak daun *Leucaena leucocephala* yang berbeza disembur pada makanan komersial. Tekstur parameter ikan Tilapia (*Oreochromis niloticus*) dinilai menggunakan tiga jenis rawatan yang berbeza (Rawatan 1=0%; Rawatan 2= 10%; Rawatan 3=20%) dari ekstrak daun *Leucaena leucocephala* sebagai diet pemakanan tambahan. Ikan tilapia yang mempunyai purata berat badan 18.3g tidak diberi makan selama sehari dan dipilih secara rawak untuk penyediaan sampel. Keputusan menunjukkan bahawa nilai maksimum kekerasan (5651 ± 65.80) dapat diperhatikan dalam Rawatan 2. Nilai kekerasan sederhana (5662.83 ± 85.26) dinilai dalam Rawatan 3 dan nilai kekerasan rendah (5579.33 ± 53.08) dalam Rawatan 1. Kohesif maksimum (0.79 ± 0.14) dinilai dalam Rawatan 3 diikuti dengan (0.53 ± 0.07) dinilai dalam Rawatan 1 dan (0.50 ± 0.03) dalam Rawatan 2. Tahap peringkat keanjalan yang tinggi dalam Rawatan 1(61.39 ± 10.24) menunjukkan keputusan yang tertinggi berbanding dengan yang lain untuk tahap keanjalan. Rawatan 3(2085.90 ± 317.63) menunjukkan keputusan yang tertinggi diikuti dengan Rawatan 1 dan Rawatan 2 (1673.03 ± 182.49) dan (1364.27 ± 89.94). Analisis menunjukkan bahawa penerimaan tekstur tertinggi adalah Nil Tilapia yang diberi ekstrak daun *Leucaena leucocephala* dalam Rawatan 3.

Kata kunci: Tekstur ikan, daun *Leucaena Leucocephala, Oreochromis niloticus,* tekstur, penilaian sensori

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LIST OF ABBREVIATIONS AND SYMBOLS

CP	Crude Protein
LLE	*Leucaena leucocephala* extract
SPSS	Software package for statistical analysis
FAO	Food and Agriculture Organization of the United Nations
ºC	Degree of Celsius
g	Gram
kg	Kilogram
ml	Millilitre
%	Percent
H_2SO_4	Sulphuric acid
CO_2	Carbon dioxide
DO	Dissolved oxygen
ppm	Parts-per-million
mg	milligram
kJ/g	Kilo joule per gram

CHAPTER 1

INTRODUCTION

1.0 Research Background

Malaysia is one of the countries that are rich in biodiversity and recognized internationally as a 'hotmega diversity country'. Within 1000 species of freshwater fish species found in the South-East Asia Tropics, 420 species can be found in Malaysia (Ismail and Sabariah, 1995; Chong et al., 2010). Besides that, in Malaysia, the freshwater fish can be divided in two zoogeographic regions. The first region is the Peninsular Malaysia, where the fishes are similar to the mainland Asiatic icthyofauna and is of Sundaie origin. The second region is West Malaysia, that is Sabah and Sarawak, which is part of zoogeographic area of Borneo, together with Sumatra and Java islands (Mohsin and Ambak 1991; Zakaria-Ismail 1994; Yap 2002).

The fishing sector in Malaysia is one of the significant economic sectors aside from the other livestock industry. The sector act as the most important role in the contribution of the protein source, the development of the downstream and upstream industries based on fisheries and the most crucial factor in the fishery industry is the production of high quality feed with adequate nutrients. Besides that, fishing sector can help in decreasing the amount of importation of the nation's food supply and increasing the growth of fishery industry in Malaysia. Aside from this, high feeding cost becomes a major limitation to the aquaculture production. Farmers concern on the ways to find an alternative for cost effective feed sources that have the potential to enhance fish performance, however this problems could be solve by developing source of feed from plant and by-product.

Fish is the most wanted protein source of food which rich in nutrients. The examples of nutrients that can be found in fish are vitamins, minerals, carbohydrate and fats, which are essential to all human beings. The percentage of human population are expect to be increase year by year and it will automatically increase in fish demand. As the amount fish consumption increases, the production of fish should be increase as it plays an important role in human nutrition.

There is about 60% of the world's population believed that fish is the primary source of protein especially in developing countries (FAO, 2008). Fish are also been classified as food that helps to prevent cardiovascular disease such as heart disorders. (Amiengheme, 2005). One of the most popular freshwater fish in Malaysia is Tilapia fish and it scientifically known as *Oreochromis niloticus*.

Oreochromis niloticus was one of the leading farmed species around the world. It was also the most abundance fish reared in Malaysia. This is because Tilapia fish or *O. niloticus* was very easy to farm and it can grow rapidly. This will help in producing a large amount of fish production in a short period. Tilapia fish is currently ranked second on to carps in global production and is likely to be the most important cultured fish in the 21st century (Ridha, 2006). The Tilapia fish was the third ranking fish species that was very important in aquaculture after carp and salmon (Lee, 2010).In addition, high growth rate and performance of Nile Tilapia in its ability to be resistant to considerable levels of adverse environmental and management conditions makes the Tilapia fish

Furthermore, texture is one of the most important criteria in accessing the quality of fish. There are some other fish species that flavourless and therefore texture has become the important criteria for consumer acceptability. The texture profile can be access by five different components, which are hardness, cohesiveness, springiness, gumminess and chewiness. There are several of methods were used to determine the texture of fish such as sensory method and instrumental method.

1.2 Problem statement

Nowadays, aquaculture production in develop countries showing the increase in growth but the rate of production is slow. As the industry have problems with constraints such as having limited availability of great quality fish feed, using alternative feed ingredients from the plant protein source can helped in managing the challenges. Besides that, the quality and texture of fish is the most important criteria in the fish production. In the latest research, texture quality is the most abuse words in food science which used to describe the characteristics of fish, from the flesh and the skin, how the process occur and the consumer preference on the fish flesh. This study is to show the consumer preference on the fish is the quality, texture and flavour of the fish.

1.3 Hypothesis

1. H null: There is no significant difference in the texture of *Oreochromis niloticus*, which fed with *Leucaena leucocephala* leaf extract.
2. H alternative: There is differences in the texture of *Oreochromis niloticus*, which fed with *Leucaena leucocephala* leaf extract.

1.4 Objective

1. To determine the effect of different concentration of *Leucaena leucocephala* leaf extract on the Tilapia fish (*Oreochromis niloticus*) texture.

1.5 Scope of study

This research project focused on the texture of the Tilapia fish which given different amount of *Leucaena leucocephala* leaf extract in the fish feed. The Tilapia fish, *Oreochromis niloticus* fingerlings given formulated feed that contain extraction of 10% and 20% content of *L. leucocephala* leaf along with the control fish feed. There were three tanks of each diet including the control feed. After two months rearing the fish, the fish filleted and cooked for the consumer evaluation by survey.

1.6 Significance of study

The research study were focused on the texture of Tilapia (*Oreochromis niloticus*) fed with different percentage of *Leucaena leucocephala* leaf meal. This study is very important because by studying on this matter, we can find other alternatives feed that is cheap and can increase the texture of the fish flesh. Other than that, this study also can prove whether the Tilapia fish fed with *L. leucocephala* leaf can increase the consumer preference on its texture. Feed prices nowadays keeps increasing due to high content of crude protein so by making this research, this can eventually solved the problems faced by the farmers. With these analysis, it was hoped that we could improve the growth and texture of the fish which can also beneficial both farmers and consumers.

1.7 Limitation of study

The research study on the texture of Tilapia (*Oreochromis niloticus*) was very few in research studies. Therefore, there are some difficulties to obtain information from previous research on the texture of fish. Besides that, many of the researcher commonly used Salmon fish and Catfish in their research project. This research were done by using different percentage of *Leucaena leucocephala* leaf extract could give effect to the texture of Tilapia fish based on the hardness, cohesiveness, springiness, gumminess and chewiness.

CHAPTER 2

LITERATURE REVIEW

2.1 *Oreochromis niloticus* (Nile Tilapia)

Tilapia was one of the well-known freshwater fish that were mostly cultured commercially in Malaysia and various part of the world such as China, Europe, United States of America, Japan and others. Tilapia fish that available in Malaysia consist of only three different species, which they were the Red Tilapia (*Oreochromis* sp.), Black tilapia (*Oreochromis niloticus*) and Javanese tilapia. Tilapia fish has the flattened longitudinal shaped and the colour of the body were usually brown or blackish grey. The side of the tilapia's dorsal fin and the ventral fin were yellow colour. However, the colour of the fish are usually different based on their species and their physiological condition. The size of tilapia fish were known to be at the range of 12 to 50 cm which differs within species.

Tilapia was originated from the Africa continent. In Asia, Indonesia was the first country that performed the Tilapia aquaculture activity, which they used Mozambique tilapia (*Oreochromis mossambicus*) in the year of 1969. Tilapia fish was firstly use and imported as the ornamental fish, but nowadays this fish was used for other production such as fish fillet, fish minced, production of cosmetics and others (Roslan, Mustapha Kamal, Md.Yunos, & Abdullah, 2014).

The population of Tilapia fish started to increase as well as its production. This Tilapia population continue to spread from one country to another country. Many people believes that Mozambique tilapia (*O. mossambicus*) fish was the first fish introduced in Malaysia and was cultured for the Japanese soldier during the World War II as the primary source of protein(Ariff et al., 2011). In the year 1980, after the Independence Day (Merdeka Day) in Malaysia, Nile Tilapia (*Oreochromis niloticus*) fish introduced in Malaysia (Ariff et al., 2011).

Additionally, the Tilapia fish or *O. niloticus* was very easy to farm and placed the third ranking fish species that was very important in aquaculture after carp and salmon (Lee, 2010). There are other types of tilapia fish which includes the *O. melanotheron*, *O. aureus* and *O. niger*. Tilapia species that were cultured were some herbivore (eat plants only) and omnivore (eat both plants and animals).However, the taste of the Tilapia meat depend on the diet of fish and water quality, which if there were changes in fish diet, it will produced strong and many different flavours in the flesh of fish.

The Tilapia fish can have bad taste if some algae present in the water, so that is the reason why water quality for the Tilapia fish needed to observed regularly (Setiawati & Suprayundi, 2003). There were many reasons that initiated Tilapia fish to be one of the favourite fish species reared in Malaysia. The reason were that the Tilapia fish have high disease resistance, highly durable, can tolerate in high density placed and could live in a low water quality. Figure 2.1 shows the structure of the Nile Tilapia fish.

Figure 2.1: The structure of the Nile tilapia fish (*Oreochromis niloticus*).

Oreochromis niloticus can survive with low level of DO at 0.9 ppm for several days. It could also survive with high Carbon Dioxide (CO_2), which was relatively high. Besides that, it recommended that Tilapia fish better cultured at the temperature of 28 ºC -32 ºC. Besides that, the water quality must observed which the volume of Dissolve Oxygen (DO) must be of $\geq$ 2.5 ppm, pH at 6-8 and have low volume of ammonia from 0.5 ppm (Amri & Khairuman, 2002).Apart from that, it was very important to know that Nile Tilapia can die at the temperature of 6 ºC or 42 ºC (Amri & Khairuman, 2002).

Therefore, Tilapia fish have high growth performance that can increases its weight in short amount of time and it is one of the reason on why tilapia was the most preferred fish species by the people in Malaysia. According to Suresh et al. (2003), Tilapia fish also known as "Saint Peter's fish" which was fed to the crowds based on the biblical passages. Tilapia fish is mainly indigenous to Africa but they also grow naturally in the Middle East (Wohlfarth et al., 1981). *Oreochromis niloticus* or Nile Tilapia is the most favoured in aquaculture as it has great performance under typical culture conditions and the production-surpassed milkfish to become second to carps.

According to Suresh et al. (2003), the success of the Nile tilapia farming is mainly because of it is easier to culture and have desirable qualities as food fish. The easiness of capturing, tolerance to both crowding and poor water quality were most of the quality in Tilapia fish. The tilapia fish has its quality as food fish, which it has white flesh, neutral taste and firm texture making it acceptable to wide-ranging of taste and preference. According to Kaliba et al., (2006), these qualities of the tilapia have earned the title of “aquatic chicken” gained more than 95 % of fish farmers to culture Tilapia.

In the current production of the Nile Tilapia, almost all the countries worldwide and all continents performed Tilapia farming. About 70 % of the production represents by the Asia, which China as the major producer, contributing half of the global production of Tilapia from year 1992 to 2003 (De Silva et al., 2004; FAO, 2014). There were two of the main species in the tilapia cultivation fisheries, were the Nile tilapia represent 90 % of the global aquaculture production (De Silva et al., 2004; Tran et al., 2011). The production of the tilapia species increases worldwide, which is about 3.4 million ton in 2013.

However, in the year of 2016, the production of the *O. niloticus* or fish known as Nile Tilapia weakened in the markets of US and Europe. Based on the industry sources, it estimated that about 40 % production of Tilapia have dropped for the year. The drop in production of Tilapia were due to the unfavourable weather conditions and lower demand of the Tilapia fish product in the markets of the USA and Europe (FAO, 2017).

In the Asia, the markets of the Tilapia fish remain firm, which also produced higher imports as well as strong local production. The fragile positions of the United States of America and Europe, as the major tilapia markets, continue into the first quarter of 2016. Nevertheless, the international trade remained positive. Based on the report from major markets and producers, the total exports for the tilapia estimated to increase by 18 % while the imports estimated to have grown to 15 % compared to the year of 2015.

In the year of 2016, the production of Tilapia fish decline due to the decline in prices as well as the adverse weather conditions. The export prices of the Tilapia fish in US dollar per kg declined by 10.7 percent for frozen fillets, six percent for breaded tilapia and 4.3 % for completely frozen products. According to the FAO (2017), in the month of January until September 2016, the country exported over 281,600 tonnes of frozen tilapia. This shows an increase of 3.4 % compared to the production in 2015. China was still the world's major producer and consumer of the Tilapia fish. The USA remains the single largest market importer of the Chinese tilapia.

In 2017, there were approximately 170,000 tonnes of Tilapia, presented as products. There were many products produced from Tilapia fish, which were the frozen whole fish, frozen fillets and fresh fillets. For a long-term, the African markets increasing more Tilapia which they import about 80 % of whole frozen Tilapia, followed by the breaded tilapia and the remaining frozen fillet. Tilapia have become one of the most important farm raised fishes and they were increasingly take their place as the major thing in the international seafood trade.

For the aquaculture industry in Malaysia, farmers are the most important role in providing the Malaysia's food fish supply. In 2016, about 1.99 million tons, valued at RM 13.18 billion (USD 3.45 billion), and the contribution from aquaculture was 506,454 tons which has valued at RM 3.3 billion (USD 0.8 billion). Malaysia's fish consumption in 2014 was the highest in Asia with 56.5 kg and the consumers preferred Tilapia fish and *Clarias* catfish.

Tilapia in Malaysia has small production than catfish but has valued at RM 223,000 (USD 58,000) which is the production of Tilapia for the local and export markets. According to Othman (2008), there were mainly tilapia and catfishes farmed in Malaysia. That was due to the availability of fry, fingerlings and commercial feed as well as the adaptability of several culture system. Besides that, the species of Tilapia farmed were red tilapia and black tilapia, *O. niloticus.*

Production of tilapia are mainly from ponds (20,516 tons), freshwater cages (7,412 tons), cement tanks 9 3,487 tons) and pen culture (<10 tons). It expected that the production of the Tilapia fish can increased in the future and give rise to the aquaculture industry. Currently, there were two commercial farms producing tilapia in floating cages in Temenggor and Kenyir Lakes. It expected to increase its total potential production capacity with 50,000 tons per year.

Recently, in Malaysia, the issues arise from the Tilapia fish, which people believed that Tilapia fish could not be consume, as the fish could be the cause of cancer. According to Department of Fishery Malaysia (2017), they stated that they can proved that the Tilapia fish was safe to eat and there were no scientific article that stated that the Tilapia fish contained cancer cells in their flesh.

The Agriculture Residue Monitoring Program (ARMP) had been carry out to observe the water quality and production of fish in every farm. This program held to ensure that the fishes produces were healthy and prevent them from diseases thus could prove that Tilapia fish can be consume by the people.

Many farmers in Malaysia used best fish strain produced and used them to reproduce to mixed breed and hybrid to produce healthier and better size fish. The hormone such as Ovaprim not needed as this only increase the cost of production and it was a waste of money to the fish industry.

2.2 *Leucaena leucocephala* (Petai Belalang)

Leucaena leucocephala is one of the medium sized fast growing tree that belongs to the family Fabacea. This tree is a native to Southern Mexico and Northern Central America (Heuzer et al., 2014). According to Hughes et al. (1998), the *L. leucocephala* tree has naturalized and planted in many tropical and sub-tropical locations. Besides that, the scientific name of this plant '*Leucocephala*' comes from the word '*leu*', which is white and '*cephala*' means the head, which refers to the flowers.

Furthermore, the plant commonly known as White Lead tree, White popinac and Wild tamarind. This tree is well known as "*Petai belalang*" in Malaysia. There were many uses of the *L. leucocephala* tree, which supported the people as a "miracle tree" (Guttridge et al., 1998). It also has labelled as a "conflict tree" for its production as a forage plant and it can spread naturally like a weed. This *L. leucocephala* tree can grows up to 20 m height and have the bipinnate leaves, white flowers tinged with yellow, and have long flattened pods. Figure 2.2 shows the *L. leucocephala* tree.

Figure 2.2: The *Leucaena leucocephala* tree.

The seeds of this tree colour were dark brown and it has shining seed coat. Numerous people uses this tree as firewood, timber, fodder, provide shade and controls soil erosion (Gardezi et al., 2004). Besides that, the kernel seeds of this plant contain more than 20 % oil and it can used as a bio energy crop. For the dairy animals, the seeds can used for the concentrates. According to Azemoddin et al. (1988), *L. leucocephala* tree can be the potential source of commercial gum.

As we all know, the *L. leucocephala* is a legume and it is symbiosis with the Rhizobia bacteria which enable the tree to fix about 500 kg of nitrogen per ha annually. According to Azemoddin et al. (1988), this nitrogen fixing nodules can found on the small lateral roots that is near the soil surface. The leaves and seeds of *L. leucocephala* were known to contain lipids, crude protein and carbohydrates while the seeds contains tannin and oxalic acid. Mimosine is one of the toxic and non-protein substance that could be found in the leaves and seeds of this plant (Table 2.1).

Table 2.1: The chemical composition contains in the leaves and seeds of the *Leucaena leucocephala* plant.

No.	Chemical composition	Leaves	Seed
1.	Crude Protein (%)	25.9	46
2.	Carbohydrate (%)	40	45
3.	Tannin (%)	4	1.2
4.	Mimosine (%)	7.19	10
5.	Total ash (%)	11	3.79
6.	Total N (%)	4.2	-
7.	Calcium (%)	2.36	4.4
8.	Phosphorus (%)	0.23	0.189
9.	B-carotene (mg/kg)	536.0	-
10.	Gross Energy (kJ/g)	20.1	-
11.	Tannin (mg/g)	10.15	-

The *L. leucocephala* have the highest quality and the most palatable fodder tress of the tropics. In Hawaii, this tree was developed as forage that provide nutritious and high protein forage for ruminants such as cattle, sheep and goats to increase the milk production and the protein supplements fed for the dairy cows (El-Harith et al., 1979). According to Wee et al. (1987), the diet supplemented with the *L. leucocephala* leaves for the fish, rodents and poultry shows good potential, cheap plant protein source with high nutritive value.

Furthermore, the wood of the *L. leucocephala* tree has a pale yellow and light reddish-brown heartwood. It has a medium density, medium textured, close grained and was easy to work for the carpentry purposes such as for the furniture and parquet flooring (Alabi et al., 2006). According to Dutt et al. (2007), the *L. leucocephala* pulp can be used in the production of paper and in rayon industries. In the modern era, people plant *L. leucocephala* in the garden and acts as a living fence. Therefore, it can also be used as supporting tree for vines such as pepper, vanilla and passion fruit.

For the agricultural purpose, the *L. leucocephala* also used as a green manure in organic farming (Gangwar et al. 2004). As the plants have large number of roots, its nodules can in fixing a great number of atmospheric nitrogen (Azeemoddin et al., 1988). The plants can be planted in the foot-hills and sandy soils to prevent natural soil erosion which can be caused by the wind and water. The *L. leucocephala* hard stem can be used to make most of the agricultural tools such as spade, axe, ploughing tools and shelves for rearing the honey bees (Abedin et al., 1990).

In conclusion, the *L. leucocephala* plant is the plant can be used in many ways. It is abundant in Malaysia but most of the plants were not use and only acts as an ornamental plants by the road. The various part of the plant such as root, leaves, stem, seed are highly useful to the human beings and for the animals. The product that can be obtain from the plant is 100 % natural and they were eco-friendly.

2.3 Texture of fish

Fish have flesh, which consist of adjacent muscle blocks, which called myotomes. Myotomes separated from each other by collagenous tissues (myocommata). The myocommata connected in the skin and to the skeletal system of the fish (Bremner, 1992). The factors that can affect the texture of fish including the species, age, size and nutritional value of the fish itself. According to Johnston (1999), the temperature during storage, cooking and presence of NaCl also influence the texture of fish. The diet given to the fish also affects its muscle composition.

One of the most important quality parameters of fish for producers, processors and consumers is texture. Texture is a very complexes sensory phenomenon, which covers all the impressions when food connect with some part of the human surface such as teeth, tongue and finger. According to Hyldig & Nielsen (2001), the processors need the texture of fish that makes the fish easy to process. Besides that, the texture of fish that gives high quality with high yields were the most preferred value by the consumers.

There were many fish species produce do not have strong flavours and thus, the texture of fish turned out to be very important for the consumer acceptability. Furthermore, according to Barroso et al. (1998), texture was influence by the intrinsic and extrinsic factors, therefore, the importance of reliable texture evaluation methods in production management is unmistakable. The favoured methods have always been on shearing, but in the recent research, it has been move headed for less-destructive process such as compression, which at the equivalent period imitate the sensory evaluation carried out in the industry, called “finger method”.

There are several methods in measuring the texture of fish, which are the sensory methods and instrumental methods. For the sensory parameter, only human that can describe the texture of fish. One of the best techniques for texture analysis is by using Texture Profile Method. These method recognized different parameter in the sensory perceptions of food. It also generates wide data matrices evaluated by multivariate data analysis.

Another method for measuring the texture of fish is by using the instrumental method that is suitable with the fish fillet. There are several types of measurement used such as puncture, shear strength and compression. Compression method is widely used and it can detect more parameters such as, hardness, cohesiveness, chewiness and springiness of fish fillet.

For the hardness of fish in texture profile analysis, it is the response of the sample to the compressor by means of time. According to Casas et al. (2006), the basic mechanical variables that measured in food are the hardness. Hardness is the peak force that compressed the fish flesh and gives an indication of the muscle to deform after the first external pressure. There were two types of hardness examined in this research. Hardness 1 refers to the first compression of the fish fillet while the Hardness 2 refers to peak force during second compression.

Cohesiveness is the property of being solid and the stickiness of fish. Cohesiveness gives an sign on how the sample tolerate the distortion during compression. According to Manju et al. (2007), the value of 1 indicate the total elasticity and the value 0 indicates the sample did not recover at all.

Springiness is the elasticity of muscle that can be stretch and leave to return to its original length. Besides that, the springiness known to be elastic and the recovering property of fish muscle during compression.

Chewiness known as the mouth feel sensation of the fish based on its elastic resistance and defined as the product of hardness × cohesiveness × springiness. By the evaluation in the mouth is highly a dynamic process in which the physicochemical properties of food could continuously altered during chewing, salivation and the temperature of the body.

CHAPTER 3

MATERIALS AND METHODS

3.1 Collection of *Leucaena leucocephala* leaves

Leaves of *Leucaena leucocephala* collected locally in Kulim, Kedah. The long stalks were remove manually by hand. The leaves were soaked for three days with changing water to avoid the leaves fermented and have faulty odours. The leaves were sun-dried for about three to four days to remove all the moisture content in the leaves. The sundried leaves were blended into fine powder and sieved to separate the powder from the fibre produced from the plant (Amisah, Oteng & Ofori, 2009). The sample was placed in an airtight container.

3.2 Proximate analysis for the *Leucaena leucocephala* leaf

Table 3.1: the composition of proximate analysis on *Leucaena leucocephala* leaf.

Overall composition	**(%)**
Crude Fat	4.58
Crude Protein	30.66
Crude Fibre	-
Ash	9.95
Moisture	15.73

3.2.1 Crude Fat

Crude fat was determined by solvent extraction method described by (Kirk and Sawyer, 1980). Wrapped Whatman filter paper with 5 gram of sample. Placed the filter paper in the thimble. The thimble then placed in the soxhlet reflux flask and were attached into a weighted extraction flask containing 200 ml of petroleum ether. The upper of the reflux flask was connected to a water condenser.

The solvent (petroleum ether) was heated, boiled vaporized and condensed into filled reflux flask. The sample in the thimble covered with its oil extract down to the boiling flask. This process was allowed to repeatedly continue for four hours before the defatted sample was removed. The solvent recovered and the oil extract left in the flask. The flask (oil extract) was then dried in the oven at 60ºC for 30 minutes to remove any residual solvent. It was cooled in the desiccator and weighed. The weighed of the oil (fat) extract was determined by difference and calculated as a percentage of the weight of sample analysed:

$$\text{Fat (\%)} = \frac{W_2 - W_1}{\text{Weight of sample}} \times 100$$

Where:

W_1 = Weight (g) of empty extraction flask

W_2 = Weight of flask + oil (fat) extract

3.2.2 Crude protein

Crude protein determined by Kjedahl method described by (Chang, 2003). The total nitrogen was determined and multiplied with factor 6.25 to obtain protein content. There were three methods involved, which were the digestion, distillation and titration.

Digestion: About 2 g of sample were placed into the Kjedahl flask and added 25 ml of concentrated sulphuric acid, 0.5 g of copper sulphate and tablet of selenium. The fume cupboard was heated slowly at first to avoid frothing, continue to digest for 45 minutes and the digest become clear pale green. The sample was allowed to cool and rapidly add 100 ml of distilled water. The digestion flask then rinsed for two-three times and add the rinsing to the bulk.

Distillation: The distillation apparatus were steamed up and 10 ml of the digest were added in a funnel and boiled. 10 ml of sodium hydroxide added from the measuring cylinder so that the ammonia contained is not lost. The flask distilled into 50 ml of 2 % boric acid contained screened methyl red indicator.

Titration: The alkaline ammonium borate formed were titrated directly with 0.1N HCl. The titre value (the volume of acid) used was recorded. The volume of acid used were fitted which becomes

$$N\,(\%) = \frac{14 \times VA \times 0.1 \times W}{1000 \times 100} \times 100$$

Where:

VA= volume of acid used

W= weight of sample

% crude protein=% N × 6.25

3.2.3 Crude Fibre

Crude fibre was determined by the method of James, (1995). Sample 5 g processed sample were then boiled in 150 ml of 1.25 % of H_2SO_4 solution for 30 minutes under reflux. The boiled sample was washed in several portions of hot water using a two-fold cloth to trap the particles. The sample was then dry before transferred to a weighed crucible where it was dried in the oven at 105 ºC to a constant weight. Then the sample were taken to furnace where they were burned. The weight of fibre was determined by the differences and calculated as:

$$\text{Crude fibre (\%)} = \frac{W_2 - W_3}{\text{Weight of sample}} \times 100$$

Where:

W_2=Weight of crucible +sample after washing, boiling and drying

W_3=Weight of crucible + sample of ash

3.2.4 Ash content

Ash content was done by the furnaces incineration by James, (1995). 5 g of sample was weighed and burned to ashes. The temperature need to burn the sample was at 550 ºC. When the sample turned to ash completely, it was cooled and weighed in the desiccator. The weight of ash was determined and calculated as a percentage of weight sample and thus:

$$\text{Ash (\%)} = \frac{W_2 - W_1}{\text{Weight of sample}} \times 100$$

Where:

W_1=Weight (g) of empty crucible

W_2=Weight of crucible + sample of ash

3.2.5 Moisture content

Moisture content was determined by the Moisture Analyser MS-70 (GPS Instrumentation Ltd.) at 160 ºC after weighing 5 g of sample on the sample pan. The instruction manual for the moisture analyser were referred according to the A&D MS-70 Moisture balance. The value of moisture content sample would appeared on the screen of moisture analyser. The data was recorded.

3.3 *Leucaena leucocephala* leaf extraction

The extraction of the dried leaves of *Leucaena leucocephala* were perform by using soxhlet apparatus. For the extraction process, distilled water was use to extract more nutrients in the leaves as distilled water was the best than any other solvents (Ilham et al., 2015). About 15 g of dried leaves undergo extraction process with 350 ml distilled water acts as the solvent. Each cycle have to be constant and the extraction process were perform for eight hours at 100 ºC. Extract were concentrated by using Rotary Evaporator at 80 ºC to diminish the amount of solvent.

The extracts of the *L. leucocephala* leaf was diluted into 10 % and 20 % treatment diet with distilled water. For the Treatment 2, 10 % concentration of *L. leucocephala*, the extract was dilute by mixing 10 ml of *L. leucocephala* leaf extract with 90 ml of distilled water. For the Treatment 3, 20% concentration of *L. leucocephala*, the extract was dilute by mixing 20 ml of *L. leucocephala* leaf extract with 80 ml of distilled water. The extracts then were stored in the refrigerator for further use.

3.4 Diet Preparation

In this experiment, commercial pellet was used to feed the Tilapia fish fingerlings. The feed pellets obtained from Star Feed Marine 9971 were used. Three diets that have different concentration of *L. leucocephala* were Treatment 1 contain 0 % of *L. leucocephala* leaf extract, Treatment 2 with 10 % of *L. leucocephala* leaf extract and Treatment 3 with 20 % of *L. leucocephala* leaf extract. For the Treatment 2, the mixture of 10 ml of *L. leucocephala* leaf extract with 90 ml of distilled water was sprayed onto 100 g of commercial pellet equally.

For the Treatment 3, about 20 ml of *L. leucocephala* leaf extract with 90 ml of distilled water was sprayed onto 100 g of commercial pellet equally. The pellet were blended carefully and placed inside the oven for 3 hours at 50 ºC until the feed dry. The feed then kept in an airtight container at room temperature (Aberoumand & Reza Abad, 2015).

Table 3.2: The diet preparation for the Tilapia fish.

Treatment	
Treatment 1 (commercial feed)	Without adding *Leucaena leucocephala* leaves
Treatment 2 (commercial feed + 10 % *Leucaena leucocephala*)	10 ml of *L. leucocephala* leaves extract with 90 ml of distilled water sprayed on commercial feed.
Treatment 3 (commercial feed + 20 % *Leucaena leucocephala*)	20 ml of *L. leucocephala* leaves extract with 90 ml of distilled water sprayed on commercial feed.

Table 3.3: Nutritional composition of the commercial feed pellet.

Overall composition	**(%)**
Fat (min)	3
Crude Protein (min)	32
Moisture (max)	12

3.5 Fish Culture

This study were conducted in Aquaculture Laboratory, Universiti Malaysia Kelantan. For this experiment, each of nine regular aquarium tanks (240×120×60cm) were filled with 1.5 m^3 of tap water was stocked with 30 *Oreochromis niloticus* fingerlings per tank. Each tank was equipped with an aerator, air tube and air stones for the production of oxygen in the tank. The water temperature and salinity during the 28-days culture period varied between 28 and 30 ºC. The weighed of the Nile tilapia fingerlings were ranged from 5 ± 1.0g each before placed in the aquarium tank.

Each of the diets used for this experiment triplicated. There were three diets given to the fingerlings which were from Treatment 1, Treatment 2 and Treatment 3. The fish fed with 3% of feed (Zaki et al., 2016), twice daily at 8.00 am and 5.00 pm. The tanks were clean about three times a week to avoid the increased concentration of ammonia in the tank.

3.6 Determination of Water Quality

The water quality parameters such as pH, Dissolved Ox1ygen (DO) and temperature taken twice a week before feeding the fish (Amisah et al., 2009). The pH, Dissolved Oxygen (DO) and temperature taken by using YSI Multiprobe parameter. All the data were recorded.

3.7 Sample preparation for analysis

The Nile tilapia fish with average weight of 18.3 g weight were starved for 1 day randomly picked for sample preparation. The fish were killed by cervical dislocation method. Cervical dislocation method were performed by identifying the location of the junction of the skull and the first cervical vertebra. The fish properly supported and demonstrated by using a sharp knife to incise between the skull and first vertebra. The fish were filleted (skin and bone-free meat) before proceed to the next method (Oceans, 2004).

3.8 Texture Analysis

The samples of the Nile tilapia fish fillet were prepared and placed outside at room temperature. Textural properties of fish meat were the hardness, cohesiveness, springiness, gumminess and chewiness of fish fillet and measured by the CT3 Brookfield Texture Analyser. The texture analyser linked with TexturePro CT Software fitted with TA4/1000 cylindrical probe. The fish fillet of each treatment was placed individually on an aluminium foil covered the flat metal plate and compressed twice using the texture analyser settings as follows: pre-test speed: 2.0 mm/s; test speed: 10.00mm/s; return speed: 10 mm/s; trigger force: 10g (Hussain, 2007).

3.9 Sensory Evaluation

The fish fillet cleaned with lemon to remove the fishy odour. The cleaned fish fillet were placed on the aluminium foil and steamed at 95-100 ºC in the steamer for five minutes to avoid loss of texture in fish. Sensory analysis on the acceptability of the Nile tilapia fish fillet carried out using 50 untrained panellist, comprising healthy undergraduate students, laboratory staff and cleaners of the Universiti Malaysia Kelantan. Fish fillets were serve on small containers for the panellist.

The panellist were ask to taste and expresesed their opinion about the acceptance of the product by giving a score to the fish fillet odour, colour, taste, texture and overall acceptability based on the scale (Score 1= Strongly disagree; Score 5= Strongly agree) in survey form. Plain water were provided to the panellists for rinsing their mouths between the samples to neutralise their sense of taste. Information such as frequency of fish consumption, age and willingness to purchase the products if available in the market was also surveyed using evaluation form (Omolara & Olaleye, 2010).

4.0 Statistical Analysis

All the data scores of each treatment in carcass and sensory data were analysed by using One-Way Analysis of Variance (ANOVA) using the SPSS of the version 16 at $P<0.05$ significant level. Variance of data was presented as standard error of means. Where significance difference occurred, treatment means were compared using Duncan Multiple Range Test (Abarike, EA & Attipoe, 2016).

CHAPTER 4

RESULTS AND DISCUSSION

This chapter explained the results obtained from the experimental work in Chapter 3 for the water quality monitoring, texture analysis and sensory evaluation for the *Oreochromis niloticus* (Nile Tilapia) fish.

Water quality monitoring was one of the most important thing that needed to be concern in managing the Nile Tilapia (*O. niloticus*) fish. The temperature, pH and dissolved oxygen (DO) were the three important parameters that were observed in this experiment.

Texture Analysis of the fish fillet of each treatment were observed using machinery method, CT3 Brookfield Texture Analyser. The difference of the texture of each treatment were observed and recorded. The fillet were analysed according to the texture parameter such as hardness, cohesiveness, springiness, gumminess and chewiness.

Sensory evaluation of the fish fillet were surveyed from the 50 respondents using questionnaires. The data obtained were recorded and presented in Table

4.1 Water Quality Monitoring

The results from the water quality monitoring during the entire research project were presented in the Table 4.1 below.

Table 4.1: Water quality parameter through the experimental period for six weeks.

Water quality parameter	Experimental data
Temperature (ºC)	26.5-27.5
pH	6.7-7.2
Dissolved Oxygen(ppm)	5.0-6.0

Based on the Table 4.1 above, the parameters, dissolved oxygen (DO) and pH were measured weekly throughout the experiment. The temperature of the water was recorded every day for the three weeks, shows no vital difference in temperature between days or tanks. After the initial period, the water temperature were measured only once a week. The water parameters do not reflect any differences among the treatments during the experimental period. The water quality were measured before the water changed every second week. The temperature of the water in tank shows at 26.5 to 27.5 ºC. This shows that the Nile Tilapia fish were in good condition as for the *Oreochromis niloticus*, the suitable temperature that needed were in between 13.5 to 33 ºC. Temperature is important in tilapia fish as they can affect the growth of the fish. Therefore, each species of Tilapia have different suitability in different temperature. According to Lee, (2010), *O. mossambicus* has the ability to withstand high temperature than the other species of tilapia fish. The Nile tilapia, *O. niloticus* cannot withstand with high temperature and could die at the temperature of 36 ºC.

4.2 Texture of tilapia fish

The fish fillet of each treatment were analysed for their difference in texture of hardness, cohesiveness, springiness, gumminess and chewiness of fish fillet. The difference of each fish fillet in different treatment were analysed and recorded.

Table 4.2 showed the texture components of fish fillet (*O. niloticus*) using CT3 Brookfield Texture Analysis. From the table, it showed that the highest value on hardness found in Treatment 2 (5651±95.54) followed by Treatment 3 (5622.83±65.80) and Treatment 1 (5579.33±53.08).

Table 4.2: The texture components of fish fillet using CT3 Brookfield Texture Analyser. Notes: Data shown were means ± standard error (SE) of triplicates.

Textural components	**Treatment 1**	**Treatment 2**	**Treatment 3**
Hardness	5579.33 ± 53.08 [a]	5651 ± 95.54 [a]	5622.83 ± 65.80 [a]
Cohesiveness	0.53 ± 0.07 [a]	0.50 ± 0.03 [a]	0.79 ± 0.14 [a]
Springiness	61.39 ± 10.24 [a]	51.23 ± 0.12 [a]	51.30 ± 0.22 [a]
Gumminess	2848 ± 310.68 [a]	2727 ± 182.87 [a]	4144.67 ± 629.51 [a]
Chewiness	673.03 ± 182.49 [a]	1364.27 ± 89.94 [a]	2085.90 ± 317.63 [a]

[a] indicates the means that with significant different (P<0.05).

Besides, Treatment 3 also showed highest values on cohesiveness (0.79±0.14), gumminess (4144.67±629.51) and chewiness (2085.90±317.63) compared to Treatment 2 (cohesiveness: 0.50±0.03; gumminess: 2727±182.87; chewiness:

1364.27±89.94) and Treatment 1 (cohesiveness: 0.53±0.07; gumminess: 2848±310.68; chewiness: 1673.03±182.49). Springiness in Treatment 1 showed 61.39±10.24, 51.23±0.12 in Treatment 2 and 51.30±0.22 in Treatment 3. However, there is no significant value between the tabulated data.

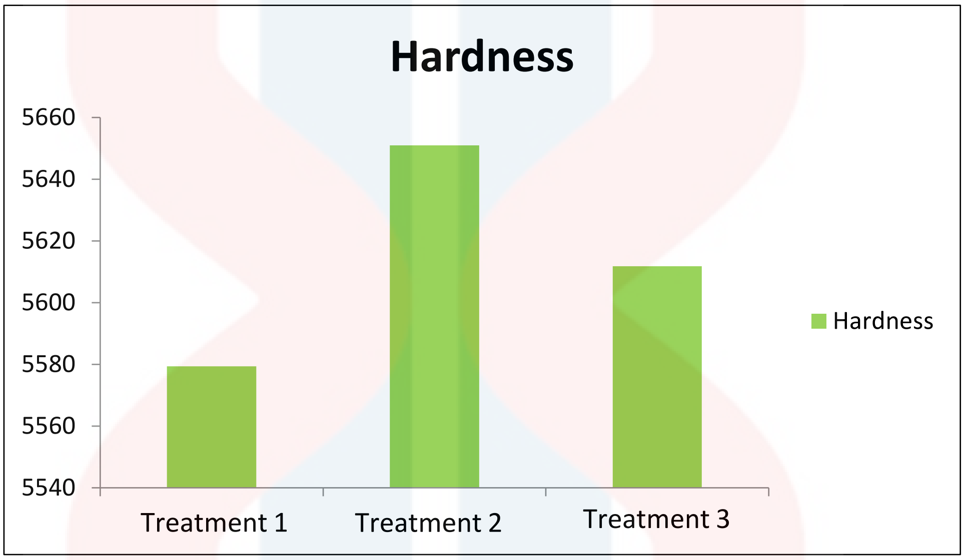

Figure 4.1: Hardness of fish fillet in each treatment

In this current study, Treatment 3 showed highest value on hardness (5622.83±65.80) which is slightly different from Treatment 2 (5651±95.54) and Treatment 1 (5579±53.08). The hardness value is the peak force that occurs during the first deepest compression. However, the hardness value obtained from this study were different from previous study. A journal stated by Guzmán et al. (2015) has stated that the value of hardness on *O. niloticus* was 40.70± 27.6. The reason underlying this observation may include the fact that the presence of higher levels of indigenous proteases in fish muscle, which leads to the breakdown of proteins after harvesting, during processing and improper handling storage (K. Subbaiah et al., 2015).

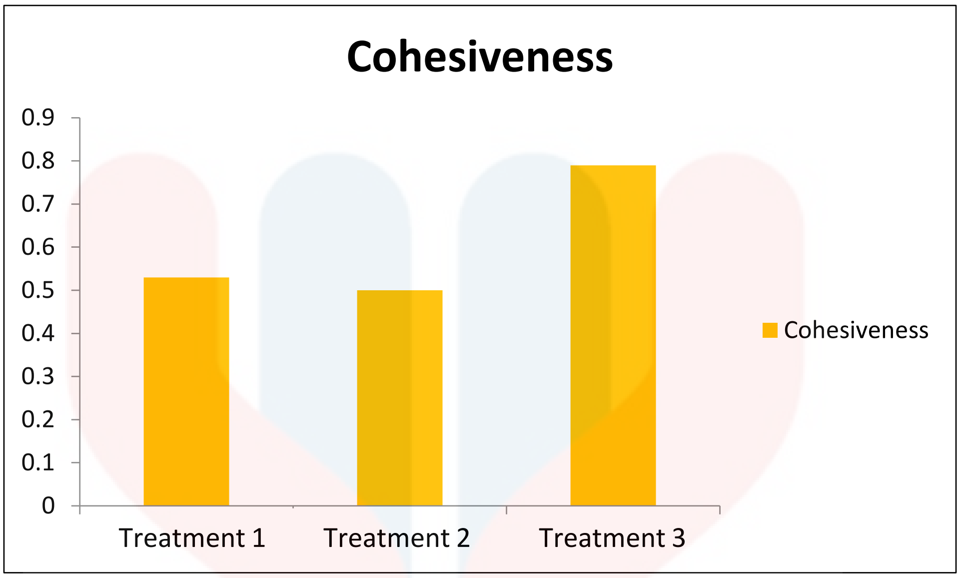

Figure 4.2: Cohesiveness of fish fillet in each treatment

On the other hand, cohesiveness is how well the fillet withstands a second deformation relative to its resistance under the first deformation. By applying 20 % of *Leucaena leucocephala* extract, Treatment 3 show higher value on cohesiveness, which is 0.79±0.14 follow by Treatment 1 (0.53±0.07) and Treatment 2 (0.50±0.03). K. Dhanapal et al. (2012) which is 0.60±0.01 have demonstrated the result obtained on cohesiveness. It showed that Treatment 1 has almost similar value as data obtained from this current study. One of the factors that would affect the cohesiveness value is lower stress on fish during handling method prior to slaughter (Cheng et al., 2014).

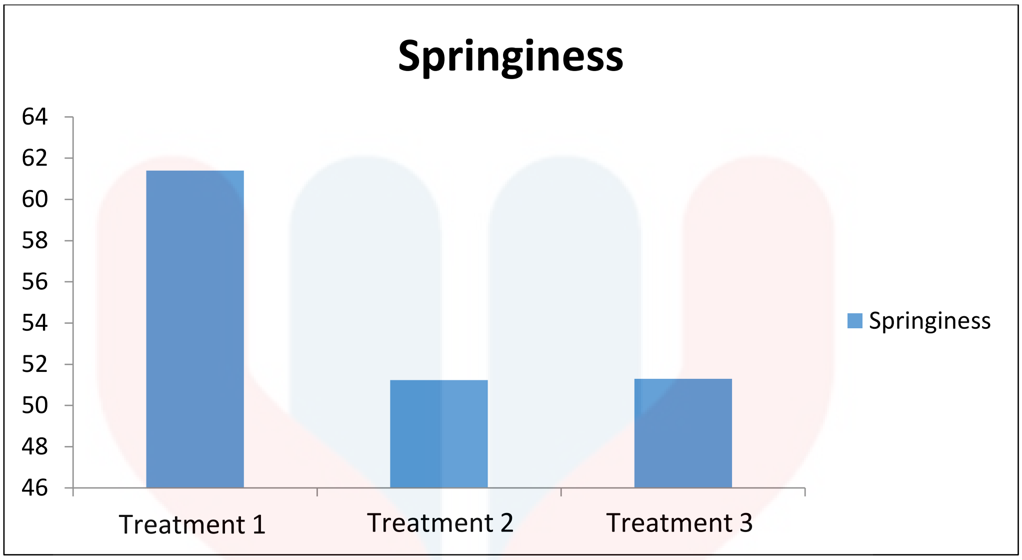

Figure 4.3: Springiness of fish fillet in each treatment

Comparing the content of springiness on Treatment 2 and Treatment 3, it show statistically similar values, which were 51.23±0.12 and 51.30±0.22. Meanwhile, springiness on Treatment 1 show the highest value (61.39±10.24) compared to Treatment 2 and Treatment 3. Springiness is how well the fillet physically springs back after it has been deformed during the first compression and has been allowed to wait for the target wait time between strokes. However, the value of springiness in *O. niloticus* fillet is not in agreement with a previous study who reported that the springiness value was 1.02±0.01 (K. Dhanapal et al., 2012). This may due to numerous factors such as the quality of the fillet was deteriorating gradually due to the breakdown of major cellular components prior to frozen storage (K. Subbaiah et al., 2015).

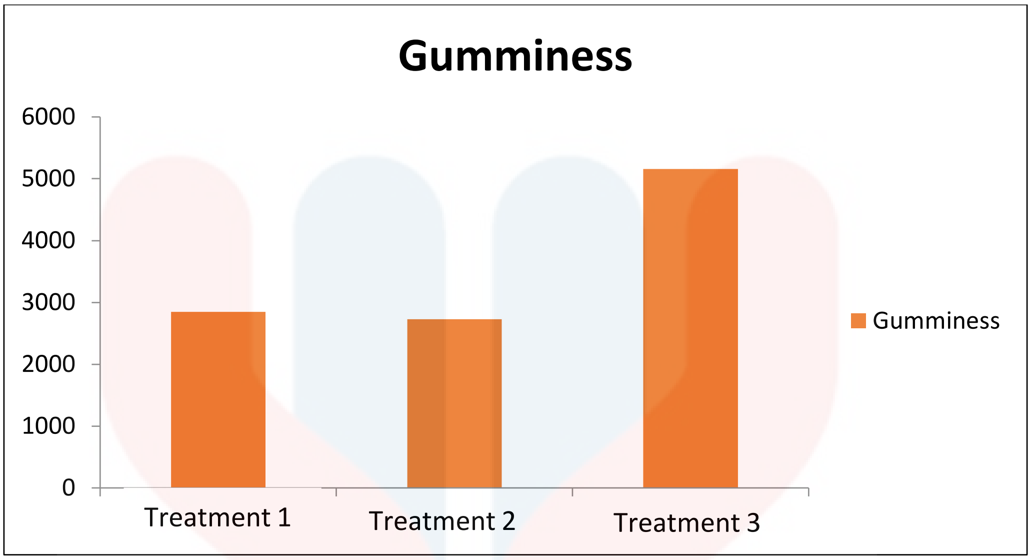

Figure 4.4: Gumminess of fish fillet in each treatment

The gumminess obtained from Treatment 2 are significantly lowest (2727±182.87) compared to Treatment 1 (2848±310.68) and Treatment 3. It seemed to be higher gumminess values obtained from Guzmán et al. (2015) and K. Dhanapal et al. (2012), which were 14.85±1.72 and 68.08±1.09. Protein denaturation has profound effect on texture quality of meat that is considered to be one of the important sensory quality attributes maybe one of the factors that affect the value on gumminess in *O. niloticus* fillet (K. Subbaiah et al., 2015).

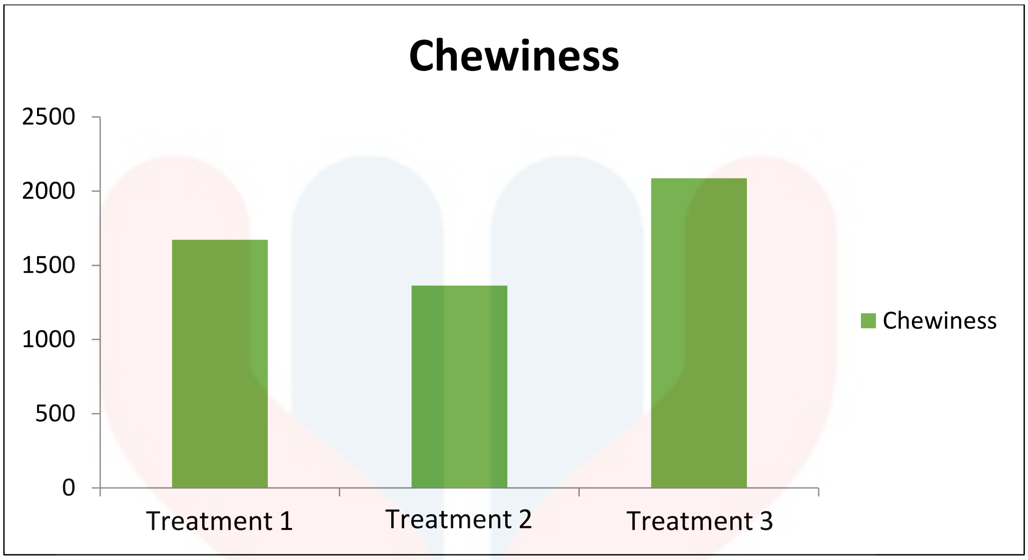

Figure 4.5: Chewiness of fish fillet in each treatment.

Following the chewiness value from the results obtained from this current study, Treatment 3 (2085.90±317.63) show highest value on chewiness follow by Treatment 1 (1673.03±182.49) and Treatment 2 (1364.27±89.94). However, K. Dhanapal et al. (2012) which is 69.37±1.45 contradicted chewiness value obtained with previous study. A possible reason for this opposing finding maybe from protein denaturation (Guzmán et al., 2015).

4.3 Sensory Evaluation of the fish texture by questionnaires

The sensory evaluation was carried out with 50 respondents in Universiti Malaysia Kelantan, which were given questionnaire on the preference of the texture of fish of three different treatments. The evaluation takes about an hour to obtain the data. All the data obtain were analysed.

There were 50 (100 %) respondents had responded to the survey. About 34 % of male and 66% of female take part in this survey. Table 4.3 show the respondents in Universiti Malaysia Kelantan with different races, age and gender. In this survey, there were mostly students at the age of 21-30. The acceptance of fish fillet were based on the socio-demographic characterization of each respondents.

Table 4.3: The percentage of respondents that take part in the survey following the socio-demographic characterization

Parameters	Frequency of respondents(n=50)	Proportion (%)
Gender		
Male	17	34
Female	33	66
Race		
Malay	31	62
Indian	8	16
Chinese	11	22
Age group		
20-below	9	18
21-30	34	68
31-40	5	10
40-above	2	4

From the Table 4.3, the higher race of respondents were Malays (62 %) that which were higher than Chinese (22 %) and Indian (16 %). It means that the Malaysian consumers from different background (especially Malay races) have started to accept freshwater aquaculture fish which was the same as reported in Perangkaan Perikanan Tahunan 2007 where the aquaculture production increases from 8-13% yearly.

Table 4.4: The preference of Nile tilapia fish fillet of each treatment.

Fish samples	Preference (%)			Total (%)
	Delicious	Neutral	Terrible	
Treatment 1	20	4	-	24
Treatment 2	22	12	-	34
Treatment 3	26	16	-	42
				100

The result for taste survey on Nile tilapia fish fillet for each treatment were presented in Table 4.4. In treatment 1, the total of respondents who preferred fillet as delicious were about 20 % while neutral for 4 %. For Treatment 2, the respondents rated 22 % for delicious and 12 % for neutral. The fillet for Treatment 3 showed that about 26 % preferred fillet as delicious and 16 % for neutral. None of the treatment above were rated as terrible. This study clearly indicated that Nile tilapia fed with *Leucaena leucocephala* leaf extracts were acceptable by the respondents in Universiti Malaysia Kelantan, even though respondents know that Tilapia fish was a freshwater fish.

Table 4.5: The taste difference of Nile tilapia fish fillet between each treatment based on tastiness, smell, attractiveness and softness of fish fillet

Fish samples	Taste difference (%)				Total (%)
	Tasty	Great smell	Attract	Soft	
Treatment 1	10	2	2	10	24
Treatment 2	16	4	2	12	34
Treatment 3	16	10	6	10	42
	42	16	10	32	100

In terms of response to the questionnaire, difference in taste, smell, attractiveness and softness of fish fillet, about 42 % choose that tilapia fillet as tasty. 16 % choose great smell, attractiveness was about 10 % and softness was about 32 %. These showed that the respondents preferred high in tastiness, softness and smell of the fish fillet. Ibrahim et al. (2014) supported this statement, proved that the tilapia was accepted because of the softness and good quality of meat.

Table 4.6: The taste difference of Nile tilapia fish fillet sorted by gender.

Gender	Preference (%)			Total (%)
	Treatment 1	Treatment 2	Treatment 3	
Male	2	7	8	17
Female	10	10	13	33
	12	17	21	100

Based on Table 4.6, the Treatment 1 respondents showed the least respondents (12 %) with 2 % male and 10 % female. In Treatment 2, was the average number of respondents which there were 17% preferred by respondents. For the highest Treatment preferred by respondents was Treatment 3 with 21% with 8% of male and 13% female. The higher preference of female choose the Tilapia fillet from Treatment 3 ,might be because of the fact that, the diet contains similar smell properties of feed that were added with *Leucaena leucocephala* leaf extract. This could be the indication of difference in sharpness in taste ability according to different gender. In addition, females were more sensitive and less "adventurous" taking risks in terms of food (Bell, Skelton & Sasi, 2000). Besides that, the preference also might be because of the fact that, the fish fillet in Treatment 3 has greyish colour. According to Boyd (2005), who explained that the consumers preferred colour of tilapia fillet is with the normal light grey to white colour of the fillet.

Table 4.7: The taste difference of Nile tilapia fish fillet sorted by age group.

Age group	Taste preference (%)			Total (%)
	Treatment 1	Treatment 2	Treatment 3	
20-below	6	4	8	18
21-30	16	24	28	68
31-40	2	4	4	10
40-above	-	2	2	4
				100

The Table 4.7 showed the age group of the respondents with the taste preference of fillet in three different treatments. In this study, there were only 4 % of tasters for the age group of 40-above, 10 % respondents from age group 31-40, 68 % respondents from 21-30 and 18 % for the age group of 20-below. The highest respondents were from the age group of 21-30 as most of the respondents were Universiti Malaysia Kelantan students. In certain studies, age been found to influence the liking, acceptance, preference, or perception of food. In opposition to the other studies found that age had no effect on the memory, hedonic response, or liking of food. These contradictions may be due to differences in each study regarding the variation in age categories and products tested. Much of the current literature for either argument compares either adolescents to adults, or young adults to the elderly, demonstrating a lack of research comparing middle-age categories to the young and elderly (Michon et al., 2010)

CHAPTER 5

CONCLUSION AND RECOMMENDATION

4.1 Conclusion

In the experiment, it highlights the ability of the *Leucaena leucocephala* leaves as fish feed, as the 20% of the *L. leucocephala* leaves extract showed highest value on cohesiveness, gumminess and chewiness. The texture of fish fed with the diet contained *L. leucocephala* extract were acceptable by the respondents in Universiti Malaysia Kelantan. Besides that, by producing the feed with *L. leucocephala* extract, the production of fish can be improve. In spite of that, it was considered that the usage of *L. leucocephala* leaves extract were provide important insight for the development of fish feed as well as improving the quality of the fish fillet. Thus, the objective of this study was accepted.

4.2 Recommendation

There are numbers of additional areas for future research in this study. These includes the further investigation on the improvement the texture of fish by using different concentration of *Leucaena leucocephala* leaf meal in fish feed. According to Osman et al. (1996), the increasing concentration of the *Leucaena leucocephala* leaves can increase the growth of the Nile tilapia fish thus this as well can improve the texture of fish. Besides that, it is recommended to use the *Leucaena leucocephala* leaf meal rather than extract, as this will consume more time and the addition of extract to the raw ingredients in fish feed such as fishmeal, rice bran and groundnut oil are much more difficult to combine together. Besides that, according to Osman et al. (1996), reported to process the *L. leucocephala* leaves by oven drying at 60 ºC for 48 hours and cooked by autoclaved for 15 minutes. These methods could increase the percentage of weight gain, growth rate and protein utilization by the fish thus; it can improve the texture of fish. Furthermore, it is suggested to monitor the water quality, which can affect the texture of fish, and low Dissolved oxygen (DO) level, fish will eat less and they will not convert to flesh efficiency. It is highly recommended to stock the fish about 10 fingerlings per tank to avoid competition among the fish and if the stocking density increased, the size of the fish will vary and this will affect the results of findings.

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APPENDICES


Appendix A.1 The *Leucaena leucocephala* tree


Appendix A.2 The *Leucaena leucocephala* legume tree


Appendix A.3 The process of collecting the *Leucaena leucocephala* tree


Appendix A.4 Process of cutting the *L. leucocephala* tree


Appendix A.5 The *Leucaena leucocephala* leaf stalk


Appendix A.6 The leaves of the *L. leucocephala* tree

Appendix A.7 The *Leucaena leucocephala* tree placed in the lorry

Appendix A.8 The *Leucaena leucocephala* leaf meal

Appendix A.9 The *Oreochromis niloticus* fish culture

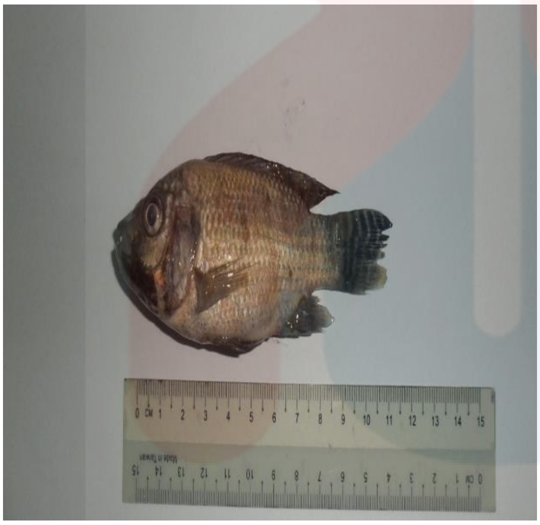
Appendix A.10 The *Oreochromis niloticus* fish in a tank.

Appendix A.11 The *Oreochromis niloticus fish*

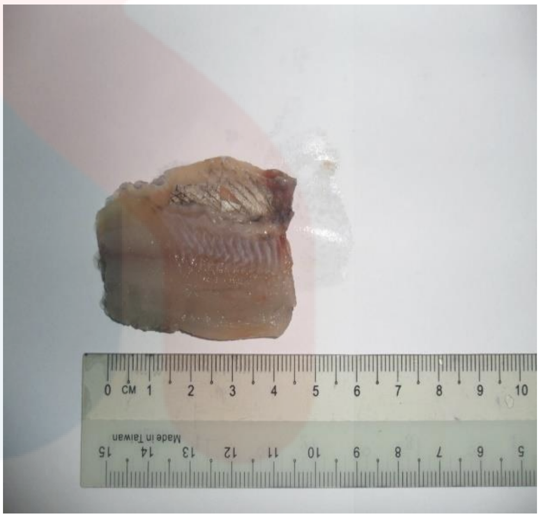
Appendix A.12 The Tilapia fish

Appendix A.13 The set-up of aquarium tank

Appendix A.14 The Tilapia fish aquarium tank

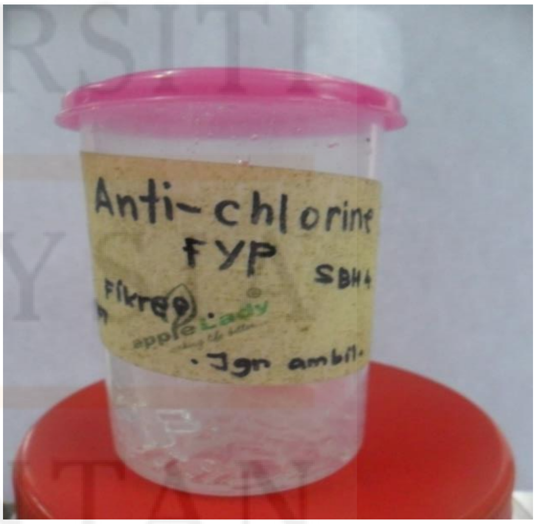


Appendix A.15 The size of Tilapia fish

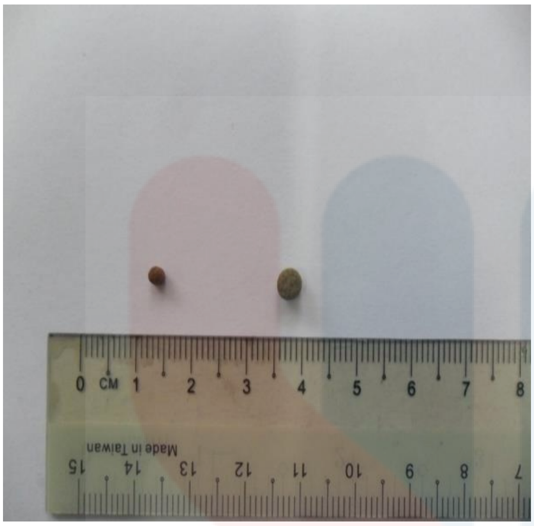


Appendix A.16 The size of Tilapia fish fillet

Appendix A.17 The liquid type of anti-chlorine used for aquarium tank



Appendix A.18 The solid type anti-chlorine used for aquarium tank



Appendix A.19 The difference in size of pellet for Tilapia fingerlings and the adult Tilapia fish

Appendix A.20 The process of cleaning the aquarium tank

Appendix A.21 The process of placing the aquarium tank

Appendix A.22 The cleaned aquarium tank

Appendix A.23 The aquarium tank

Appendix A.24 The fish in cleaned aquarium tank

Questionnaire:

TEXTURE QUALITY OF FILLET OF FISH

Dear Respondent,

My name is Aida Syazana Bt Musa and currently pursuing Bachelor of Applied Science (Animal Husbandry) in University of Malaysia Kelantan. This questionnaire used for my thesis and entitled "**The effect of *Leucaena leucocephala* Leaf Meal on the Texture of Nile Tilapia (*Oreochromis niloticus*) Fingerlings"** in completion of my degree. The information that collected used for academic purpose and kept confidential. Your co-operation is highly solicited. Thank you for your feedback.

Please tick (/) on the number from scale 1 to 5 based on the :

1- Strongly disagree	2-Disagree	3-Neutral	4-Agree	5-Strongly agree

1. I like to consume fish

   1 2 3 4 5

2. How frequent did you consume fish in a week?

   1 2 3 4 5

3. Have you ever eat Tilapia fish?

   1 2 3 4 5

4. Do you like steam fish?

   1 2 3 4 5

5. What is your gender?

   Male Female

6. What is your age?

   20-below 21-30 31-40 40-above

7. What is your race?

   Malay Indian Chinese Others (please state): __________

8. Which sample of fish has better taste?

   A B C

9. Which sample has best smell?

   A B C

10. Which sample has bad smell?

    A B C

11. Best colour fillet you like:

    A B C

12. Which sample that attract you to taste it?

    A B C

13. Which sample fillet is soft?

    A B C

14. Have you ever tried to eat Tilapia fish before?

    Yes No

15. How would you rate the fillet of A?

    Delicious Not bad Terrible

16. How would you rate the fillet of B?

    Delicious Not bad Terrible

17. How would you rate the fillet of C?

    Delicious Not bad Terrible

18. Do you want to buy the fish fillet product in the future?

Yes No

Do you have any suggestion on how to improve this sample?

____

Thank you for spending your time answering this survey.